CLAIMS

What is claimed is:

1. A method of delivery to the pulmonary system comprising:

administering to the respiratory tract of a patient in need of treatment, prophylaxis or diagnosis an effective amount of a dry powder comprising:

a) a multivalent metal cation which is complexed with a therapeutic, prophylactic or diagnostic agent;

b) a pharmaceutically acceptable carrier; and

c) optionally, a multivalent metal cation-containing component

wherein, the total amount of multivalent metal cation present in the dry powder is more than 1 % w/w of the total weight of the agent and wherein release of the agent is sustained.

2. The method of Claim 1, wherein the biologically active agent is a protein.

3. The method of Claim 2, wherein the protein is insulin.

4. The method of Claim 2, wherein the multivalent metal cation is selected from Zn(II), Ca(II), Cu(II), Ni(II), Co(II), Fe(II), Ag(II), Mn(II), Mg(II) or Cd(II).

5. The method of Claim 4, wherein the multivalent metal cation is Zn(II).

6. The method of Claim 2, wherein the multivalent metal cation is present at a ratio of more than about 2% w/w of the total weight of the agent.

7. The method of Claim 2, wherein the multivalent metal cation is present at a ratio of more than about 5% w/w of the total weight of the agent.

8. The method of Claim 2, wherein complexation of the agent and multivalent metal cation comprises a metal coordination.

9. The method of Claim 2 wherein the dry powders have a tap density less than about 0.4 g/cm^3.

10. The method of Claim 9, wherein the dry powder have a tap density less than about 0.1 g/cm^3.

11. The method of Claim 2, wherein the dry powder have a median geometric diameter of from about 5 micrometers and about 30 micrometers.

12. The method of Claim 2, wherein the dry powder have an aerodynamic diameter of from about 1 to about 5 microns.

13. The method of Claim 12, wherein the dry powder have an aerodynamic diameter of from about 1 to about 3 microns.

14. The method of Claim 12, wherein the dry powder have an aerodynamic diameter of from about 3 to about 5 microns.

15. The method of Claim 2, wherein delivery to the pulmonary system includes delivery to the deep lung.

16. The method of Claim 2, wherein delivery to the pulmonary system includes delivery to the central airways.

17. The method of Claim 2, wherein delivery to the pulmonary system includes delivery to the upper airways.

18. The method of Claim 2, wherein the dry powder further comprise a carboxylic acid.

19. The method of Claim 18, wherein the carboxylic acid includes at least two carboxyl groups.

20. The method of Claim 19, wherein the carboxylic acid is citric acid or a salt thereof.

21. The method of Claim 2, wherein the dry powder further comprise an amino acid.

22. The method of Claim 21, wherein the amino acid is hydrophobic.

23. The method of Claim 22, wherein the hydrophobic amino acid is leucine, isoleucine, alanine, valine, phenylalanine or any combination thereof.

24. The method of Claim 2 wherein the pharmaceutically acceptable carrier is a phospholipid.

25. The method of Claim 24 wherein the phospholipid is a phosphatidic acid, a phosphatidylcholine, a phosphatidylalkanolamine, a phosphatidylethanolamine, a phosphatidylglycerol, a phosphatidylserine, a phosphatidylinositol or combinations thereof.

26. A method of delivery to the pulmonary system comprising:

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administering to the respiratory tract of a patient in need of treatment, prophylaxis or diagnosis an effective amount of a dry powder comprising:

a) a protein which is complexed with zinc;

b) a pharmaceutically acceptable carrier; and

c) optionally, a multivalent metal cation-containing component

wherein, the total amount of multivalent metal cation present in the dry powder is more than about 2 % w/w of the total weight of the agent, delivery includes the deep lung and release of the agent is sustained.

27. The method of Claim 26, wherein the dry powder has a tap density less than about 0.1g/cm^3 and a median geometric diameter of from about 5 micrometers and about 30 micrometers.

28. The method of Claim 26, wherein the pharmaceutically acceptable carrier is a phospholipid.

29. The method of Claim 26 wherein the dry powder further comprises a carboxylic acid.

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30. A composition for delivery to the pulmonary system comprising:

a) an effective amount of dry powder of a therapeutic, prophylactic or diagnostic agent which are complexed to a multivalent metal cation wherein the agent has a charge which is opposite to that of the cation;

b) a pharmaceutically acceptable carrier; and

c) optionally, a multivalent metal cation-containing component

wherein, the dry powder have a total amount of multivalent metal cation which is more than 1 % w/w of the total weight of the agent, a tap density of less than about 0.4 g/cm^3, a median geometric diameter of from about 5 micrometers and

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about 30 micrometers and an aerodynamic diameter of from about 1 to about 5 microns.

31. The composition of Claim 30, wherein the biologically active agent is a protein.

32. The composition of Claim 31, wherein the protein is insulin.

33. The composition of Claim 30 wherein the multivalent metal cation is selected from Zn(II), Ca(II), Cu(II), Ni(II), Co(II), Fe(II), Ag(II), Mn(II), Mg(II) or Cd(II).

34. The composition of Claim 33, wherein the multivalent metal cation is Zn(II).

35. The composition of Claim 30, wherein the multivalent metal cation is present at a ratio of more than about 2% w/w of the total weight of the agent.

36. The composition of Claim 30, wherein the multivalent metal cation is present at a ratio of more than about 5% w/w of the total weight of the agent.

37. The composition of Claim 30, wherein complexation of the agent and multivalent metal cation comprises a metal coordination.

38. The composition of Claim 30, wherein the dry powder have a tap density less than about 0.1 g/cm^3.

39. The composition of Claim 30, wherein the dry powder have an aerodynamic diameter of from about 1 to about 3 microns.

40. The composition of Claim 30, wherein the dry powder have an aerodynamic diameter of from about 3 to about 5 microns.

41. The composition of Claim 30 wherein the dry powder further comprise a carboxylic acid.

42. The composition of Claim 41, wherein the carboxylic acid includes at least two carboxyl groups.

43. The composition of Claim 42, wherein the carboxylic acid is citric acid or a salt thereof.

44. The composition of Claim 30, wherein the dry powder further comprise an amino acid.

45. The composition of Claim 44, wherein the amino acid is hydrophobic.

46. The composition of Claim 45, wherein the hydrophobic amino acid is leucine, isoleucine, alanine, valine, phenylalanine or any combination thereof.

47. The composition of Claim 30 wherein the pharmaceutically acceptable carrier is a phospholipid.

48. The composition of Claim 47 wherein the phospholipid is a phosphatidic acid, a phosphatidylcholine, a phosphatidylalkanolamine, a phosphatidylethanolamine, a phosphatidylglycerol, a phosphatidylserine, a phosphatidylinositol and combinations thereof.

49. A composition for delivery to the pulmonary system comprising:

administering to the respiratory tract of a patient in need of treatment, prophylaxis or diagnosis an effective amount of a dry powder comprising:

a) a protein which is complexed with zinc;

b) a pharmaceutically acceptable carrier; and

c) optionally, a multivalent metal cation-containing component

wherein, the total amount of multivalent metal cation present in the dry powder is more than about 2 % w/w of the total weight of the agent, delivery includes the deep lung and release of the agent is sustained.

50. The method of Claim 49, wherein the dry powder has a tap density less than about 0.1g/cm^3 and a median geometric diameter of from about 5 micrometers and about 30 micrometers.

51. The method of Claim 49, wherein the pharmaceutically acceptable carrier is a phospholipid.

52. The method of Claim 49 wherein the dry powder further comprises a carboxylic acid.